



# Annex 52

## Long-term performance monitoring of GSHP systems for commercial, institutional, and multi-family buildings

**Ground-source heat pump (GSHP) systems for larger buildings provide renewable heating and cooling for a wide range of system applications. Long-term performance measurements from such systems are valuable tools for commissioning, fault detection, system optimization and component development. Broad consensus on instrumentation, monitoring and analysis of long-term performance leads to further energy and cost savings.**

### Key Findings

- 1 The previously defined SEPEMO system boundary schema is insufficient for treating the complexity of large-scale GSHP systems. The Annex 52 system boundary schema with six defined boundaries and an indicator for use of supplementary heating or cooling (Fig. 1), better captures the complex nature of large GSHP systems.
- 2 Performance indicators for GSHP systems require clearly stated system boundaries as well as the time frame at which the performance is evaluated. Seasonal performance factors (SPF) should be used only for measured performance over a full year. Measured performance over shorter time intervals - daily (DPF), monthly (MPF) or binned performance factors (BPF) - are also valuable performance indicators.
- 2 Uncertainty analysis of performance data is rarely reported, despite being an important tool to help design the measurement program and understand the significance of its results. Annex 52 provide guidelines aimed at the application of uncertainty analysis to measurements made to monitor performance of GSHP systems.
- 4 The monitoring projects report a combined total of 116 years of data, with combined heating and cooling SPFHC1 (boundary 1 in Fig. 1) in the range 1.5-7.2 with an average of 4. 88% of the measured years have SPFHC1 of 3 or higher. SPFHC2 are in the range 1.4-12.6 with an average of 4.6. 80% of the project-years have SPFHC2 of 3 or higher.
- 5 The projects carried out within Annex 52 (Fig. 2) show that most systems work satisfactorily although there is room for further improvement and optimization. The distribution system on the load side of the heat pump has a detrimental effect on the system performance at system boundaries 3-5. Energy use for hot water, distribution pumps and fans are common causes.

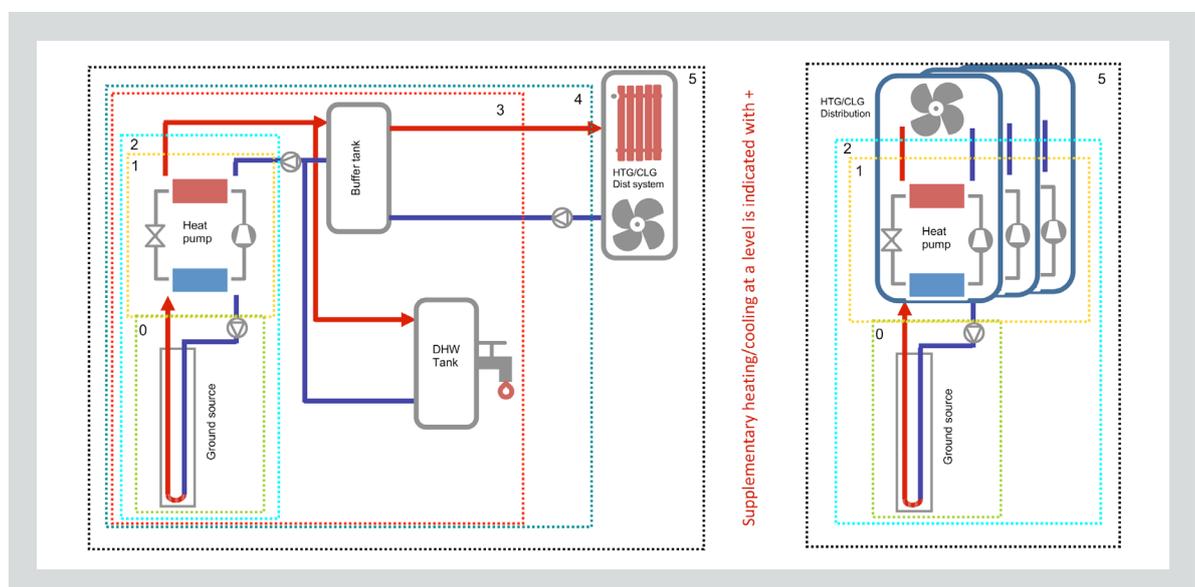


Figure 1: Annex 52 system boundary schema. Centralized GSHP system (left) and Distributed GSHP system (right).

							
 RESIDENTIAL BUILDING	4	1	1	-	-	-	-
 COMMERCIAL BUILDING	9	5	4	3	1	1	2
 INDUSTRIAL BUILDING	1	-	-	-	-	-	-
 BOREHOLES	12	3	5	1	1	1	-
 GROUNDWATER	2	-	-	1	-	-	2
 ENERGY PILES	-	3	-	1	-	-	-

Figure 2: Overview of GSHP monitoring projects within Annex 52.

## Background

Field measurements of building heating and cooling system performance are rarely made but essential to ensure that performance expectations are actually met. For GSHP systems, owners have made significant investments with expectations of high performance. Hence, it is particularly important that high performance be achieved. Though some field measurements have been reported in the literature, there is little or no consistency on how to measure the performance or how to report the results. Cost-effective measurement programs are hindered by this lack of consistency and a lack of guidance regarding measurement system design.

Annex 52 involved long-term performance measurements of 32 large-scale GSHP systems in 7 countries. Outcomes from the annex include new boundary schema and guidelines for instrumentation, uncertainty, key performance indicators, data management, and quality assurance. The outcomes will lower the cost for obtaining robust, accurate, and consistent measurements of performance. Lowering the cost will in turn lead to wider

adoption of performance measurement schemes, increased energy and cost savings, and increased benchmarking leading to better understanding of system design and performance expectations.

## Objectives

The objectives of Annex 52 have been to:

- » Create a library of quality long-term measurements of GSHP system performance for commercial, institutional and multi-family buildings served by any type of ground source (rock, soil, groundwater, surface water).
- » Refine and extend current methodology to better characterize large-scale GSHP system performance and to provide a set of benchmarks for comparisons of such systems.
- » Provide guidance for instrumentation, uncertainty calculation, key performance indicators and system boundaries that cover as many GSHP system features as possible.

## Further information

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